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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
98/202/WBH		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/00568	17/02/2000	18/02/1999
International Patent Classification (IPC) or national classification and IPC G08G1/042		
Applicant THE UNIVERSITY COURT OF THE UNIVERSITY OF et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
18/09/2000	06.11.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Faoro, G Telephone No. +49 89 2399 2650

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/00568

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-7 as originally filed

Claims, No.:

1-11 as originally filed

Drawings, sheets:

1/4-4/4 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-11
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-11
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

2. Citations and explanations

see separate sheet

To section V

The invention relates to a vehicle detector and classifier comprising at least one electrical conductive loop arranged in a road surface.

In order to provide a vehicle detector capable of detecting vehicle wheels and tires (so as to enable classification of the vehicle according to the number, type and position of ales or wheels) more accurately than prior art systems (e.g. the in the application cited EP-A-0649553) having the conductive loops arranged on the road plane, the present application is proposing to have the loops arranged perpendicularly to the road surface so as to detect the increase of loop inductance caused by a tyre while minimizing the opposite influence of the metallic masses of the body of the vehicle.

The three documents cited in the International Search Report disclose different arrangements for detecting the metallic mass of vehicles all making use of magnetic sensors and not of inductive loops.

The solution proposed in claim 1 of the present application can therefore be considered as involving an inventive step (Article 33(3) PCT) as none of the cited prior art documents disclose or suggest the use of electrical conducting loops arranged perpendicularly to the road surface.

The demand must be filed directly with the competent International Preliminary Examining Authority if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ _____

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION

Applicant's or agent's file reference: WBH

International application No.	International filing date *(day/month/year)*	(Earliest) Priority date *(day/month/year)*
PCT/GB 00/00568	17 February 2000 (17.02.00)	18 February 1999 (18.02.99)

Title of invention: VEHICLE DETECTOR AND CLASSIFIER

Box No. II APPLICANT(S)

Name and address: *(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)*
The University Court Of
The University of Edinburgh,
Old College,
South Bridge,
Edinburgh EH8 9YL,
United Kingdom

Telephone No.:

Facsimile No.:

Teleprinter No.:

State *(that is, country)* of nationality: United Kingdom

State *(that is, country)* of residence: United Kingdom

Name and address: *(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)*
POVEY, Gordon, Johnston, Robertson
3 Forbes Terrace,
Salisbury Street,
Kirkcaldy,
Fife KY2 5HW,
United Kingdom

State *(that is, country)* of nationality: United Kingdom

State *(that is, country)* of residence: United Kingdom

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*
MACLEAN, Thomas, Stewart, McKenzie
16 Fairies Road,
Perth PH1 1NB,
United Kingdom

State *(that is, country)* of nationality: United Kingdom

State *(that is, country)* of residence: United Kingdom

☐ Further applicants are indicated on a continuation sheet.

International application No.
PCT/GB00/00568

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is [x] agent [ ] common representative

and [x] has been appointed earlier and represents the applicant(s) also for international preliminary examination.

[ ] is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.

[ ] is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

HANSON, William Bennett
J.Y. & G.W. Johnson
Kingsbourne House,
229-231 High Holborn,
London WC1V 7DP,
United Kingdom

Telephone No.: 020 7405 0356

Facsimile No.: 020 7831 9628

Teleprinter No.:

[ ] **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special addr ess to which correspondence should be sent.

Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

Statement concerning amendments:*

1. The applicant wishes the international preliminary examination **to start on the basis of:**

[x] the international application as originally filed

the description [ ] as originally filed
[ ] as amended under Article 34

the claims [ ] as originally filed
[ ] as amended under Article 19 (together with any accompanying statement)
[ ] as amended under Article 34

the drawings [ ] as originally filed
[ ] as amended under Article 34

2. [ ] The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.

3. [ ] The applicant wishes the start of the international preliminary examination **to be postponed** until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English

[x] which is the language in which the international application was filed.
[ ] which is the language of a translation furnished for the purposes of international search.
[ ] which is the language of publication of the international application.
[ ] which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

Box No. V ELECTION OF STATES

The applicant hereby **elects all eligible States** *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes **not to elect:**

International application No.
PCT/GB00/00568

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:			For International Preliminary Examining Authority use only: received	not received
1. translation of international application	:	sheets	☐	☐
2. amendments under Article 34	:	sheets	☐	☐
3. copy (or, where required, translation) of amendments under Article 19	:	sheets	☐	☐
4. copy (or, where required, translation) of statement under Article 19	:	sheets	☐	☐
5. letter	:	sheets	☐	☐
6. other *(specify)*	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1. [x] fee calculation sheet
2. [ ] separate signed power of attorney
3. [ ] copy of general power of attorney; reference number, if any:
4. [ ] statement explaining lack of signature
5. [ ] nucleotide and or amino acid sequence listing in computer readable form
6. [ ] other *(specify)*:

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

William Hanson

William B. HANSON

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:
2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):
3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.
4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.
5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

See Notes to the demand form

CHAPTER II

PCT

FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No. PCT/GB00/00568	For International Preliminary Examining Authority use only
Applicant's or agent's file reference WBH	Date stamp of the IPEA

Applicant
THE UNIVERSITY COURT
OF THE UNIVERSITY OF EDINBURGH

Calculation of prescribed fees

1. Preliminary examination fee	EUR 1533	P
2. Handling fee *(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)*	EUR 147	H
3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box	EUR 1680	TOTAL

Mode of Payment

[X]	authorization to charge deposit account with the IPEA (see below)	[ ]	cash
[ ]	cheque	[ ]	revenue stamps
[ ]	postal money order	[ ]	coupons
[ ]	bank draft	[ ]	other *(specify)*:

Deposit Account Authorization *(this mode of payment may not be available at all IPEAs)*

The IPEA/ EP [X] is hereby authorized to charge the total fees indicated above to my deposit account.

[ ] *(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

J.Y. & G.W. Johnson

28050017	18.09.00.	Williamson
Deposit Account Number	Date *(day/month/year)*	Signature

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
98/202/WBH		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 00568	17/02/2000	18/02/1999
Applicant		
THE UNIVERSITY COURT OF THE UNIVERSITY OF et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of Invention Is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

PCT REQUEST

98/202/WBH

Original (for **SUBMISSION**) - printed on 16.02.2000 05:49:58 PM

0	**For receiving Office use only**	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	**Form - PCT/RO/101 PCT Request**	
0-4-1	Prepared using	PCT-EASY Version 2.90 (updated 15.12.1999)
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	United Kingdom Patent Office (RO/GB)
0-7	**Applicant's or agent's file reference**	98/202/WBH
I	**Title of invention**	VEHICLE DETECTOR AND CLASSIFIER
II	**Applicant**	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	THE UNIVERSITY COURT OF THE UNIVERSITY OF EDINBURGH
II-5	Address:	Old College South Bridge Edinburgh, EH8 9YL United Kingdom
II-6	State of nationality	GB
II-7	State of residence	GB
III-1	**Applicant and/or inventor**	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	POVEY, Gordon, Johnston, Robertson
III-1-5	Address:	3 Forbes Terrace Salisbury Street Kirkcaldy, Fife KY2 5HW United Kingdom
III-1-6	State of nationality	GB
III-1-7	State of residence	GB

PCT REQUEST

98/202/WBH

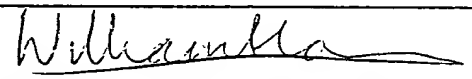
Original (for SUBMISSION) - printed on 16.02.2000 05:49:58 PM

III-2	**Applicant and/or inventor**	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	MACLEAN, Thomas, Stewart, McKenzie
III-2-5	Address:	16 Fairies Road Perth, PH1 1NB United Kingdom
III-2-6	State of nationality	GB
III-2-7	State of residence	GB
IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	HANSON, William, Bennett
IV-1-2	Address:	JY & GW Johnson Kingsbourne House 229-231 High Holborn London, WC1V 7DP United Kingdom
IV-1-3	Telephone No.	+44 20 7405 0356
IV-1-4	Facsimile No.	+44 20 7831 9628
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	JP US
V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	**Exclusion(s) from precautionary designations**	NONE

PCT REQUEST

98/202/WBH

Original (for **SUBMISSION**) - printed on 16.02.2000 05:49:58 PM

VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	18 February 1999 (18.02.1999)	
VI-1-2	Number	9903783.0	
VI-1-3	Country	GB	
VI-2	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	**International Searching Authority Chosen**	European Patent Office (EPO) (ISA/EP)	
VIII	**Check list**	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	7	-
VIII-3	Claims	2	-
VIII-4	Abstract	1	98202abs.txt
VIII-5	Drawings	4	-
VIII-7	TOTAL	18	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	**Figure of the drawings which should accompany the abstract**	1	
VIII-19	**Language of filing of the international application**	English	
IX-1	**Signature of applicant or agent**		
IX-1-1	Name (LAST, First)	HANSON, William, Bennett	

FOR RECEIVING OFFICE USE ONLY

10-1	**Date of actual receipt of the purported international application**	
10-2	**Drawings:**	
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/EP
10-6	**Transmittal of search copy delayed until search fee is paid**	

PCT REQUEST

98/202/WBH

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FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G08G 1/042, 1/015 — A1

(11) International Publication Number: **WO 00/49590**

(43) International Publication Date: 24 August 2000 (24.08.00)

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(22) International Filing Date: 17 February 2000 (17.02.00)

(30) Priority Data:
9903783.0 18 February 1999 (18.02.99) GB

(71) Applicant *(for all designated States except US)*: THE UNIVERSITY COURT OF THE UNIVERSITY OF EDINBURGH [GB/GB]; Old College, South Bridge, Edinburgh EH8 9YL (GB).

(72) Inventors; and

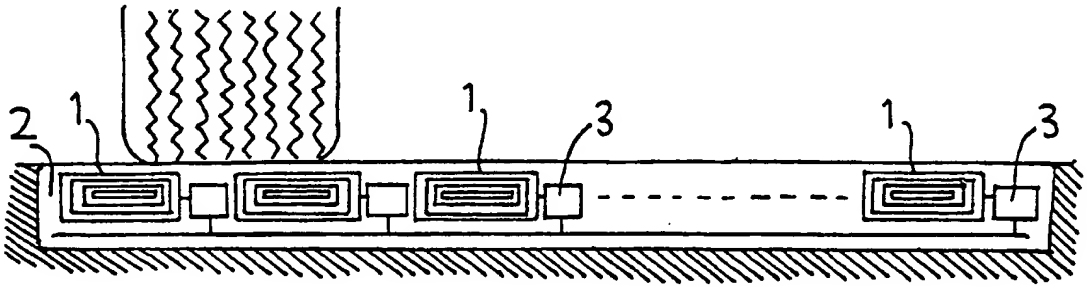
(75) Inventors/Applicants *(for US only)*: POVEY, Gordon, Johnston, Robertson [GB/GB]; 3 Forbes Terrace, Salisbury Street, Kirkcaldy, Fife KY2 5HW (GB). MACLEAN, Thomas, Stewart, McKenzie [GB/GB]; 16 Fairies Road, Perth PH1 1NB (GB).

(74) Agent: HANSON, William, Bennett; JY & GW Johnson, Kingsbourne House, 229-231 High Holborn, London WC1V 7DP (GB).

(81) Designated States: JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: VEHICLE DETECTOR AND CLASSIFIER



(57) Abstract

A vehicle detector and classifier comprises a plurality of electrically conductive loops (1) arranged substantially in a plane perpendicular to a road surface, for detecting vehicle wheels. The loops can be arranged in a transverse, vertical slot (2) and housed in a flexible enclosure. An electronic circuit (3), including an oscillator, can be positioned adjacent each loop (1) in the slot (2) to energise and monitor the loop. The detector preferably also includes a conventional loop arranged substantially in the plane of the road surface, for detecting vehicle bodies, and means for superposing the results obtained from the conventional and vertical loops to aid in classifying detected vehicles.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
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CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
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CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
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DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

VEHICLE DETECTOR AND CLASSIFIER

Background to the Invention

The present invention relates to a vehicle detector and classifier.

There is a growing world-wide market for systems for detecting and classifying road vehicles. Road tolling, road pricing, and traffic monitoring and control are becoming increasingly important. Such systems are also likely to be of use in the automated or intelligent highways of the future. Accurate, low cost, low maintenance sensors are required which can not only detect but classify vehicles for automatic tolling and priority lane enforcement. The invention is also applicable to aircraft ground control and military vehicle classification.

One form of vehicle detector in common use comprises one or two large loops of electrically conductive material which are arranged on or in a road, substantially in the plane of the road surface. Vehicles are detected by the reduction in the inductance of the loop caused by the metallic vehicle body passing thereover.

Whilst detectors of this kind can be used to classify vehicles according to their length, they do not detect the axles or wheels of the vehicle and hence classification according to the number, type and position of axles or wheels is not possible. Such classification is, however, the accepted and sensible way to classify vehicle types.

Axle classification can be achieved by using a pneumatic tube or piezoelectric sensor in addition to the inductive loop. However, this adds to the cost, is impractical on unsurfaced roads, has a limited life span and cannot detect individual wheel configurations.

It is therefore highly desirable to provide an inductive loop vehicle detector which can detect vehicle wheels.

EP-A-0,649,553 describes a vehicle detector comprising at least one and up to eight inductive loops, having a width (extending in the direction of travel) only substantially equal to the bearing surface on the ground of the vehicle wheel (i.e. about 0.3 m for heavy goods vehicles or 0.15 m for light vehicles). The or each loop is arranged substantially in the plane of the road surface. This arrangement is able to detect vehicle wheels although the influences of the metallic masses of the body and of the tyres of the vehicle on such small loops are opposed.

The reason given in EP-A-0,649,553 for these opposite influences is that the loop or loops constitute a first electrical circuit, and the metallic mass of the vehicle causes a variation in the magnetic field produced by the first circuit, which in turn causes a variation in the flux linking a second circuit formed by the metallic masses in the wheel and, more particularly, by the torus formed by the wheel rim and the metallic tyre reinforcements, thus inducing a current in the second circuit.

We believe that such reasoning is erroneous since it would cause a change in the inductance of the loop opposite to the results actually described and shown in EP-A-0,649,553. In fact, whilst the large conducting area of a vehicle body causes a decrease in the loop inductance due to eddy currents, the vehicle tyre contains ferrous metal but in the form of steel bands or webbing, not in the form of a large conducting sheet. The vehicle tyre thus has a high magnetic permeability, but a relatively low electrical conductivity, and causes an increase in the loop inductance.

Summary of the Invention

It is an aim of the present invention to provide a vehicle detector which is able to detect vehicle wheels, tyres

and hence axles more accurately than has been possible hitherto.

Accordingly, the present invention comprises a vehicle detector and classifier comprising at least one electrically conductive loop arranged in a road surface, characterised in that the or each loop is arranged substantially in a plane perpendicular to the road surface.

Said plane may extend parallel to the axis of the road, i.e. in the direction of travel, but preferably it extends across the road. This means that a plurality of loops may be arranged in a line in a single transverse slot cut into the road surface.

The or each loop may comprise a plurality of turns. The signal processing circuitry used to sample the inductance of the loop and operate on the samples may comprise one of a number of conventional arrangements currently used in inductive loop vehicle detectors. In this regard, some of the active electronic components, such as the oscillator, can be located in the slot adjacent to the or each loop so as to reduce interference between the loops and reduce crosstalk between the circuits. Any such components are preferably mounted on very small hybrid or thick-film circuits at regular intervals. The loop, or all of the loops, and optionally the locally mounted components, are preferably encapsulated in a semi-rigid enclosure which is strong yet flexible so as to be able to withstand the forces exerted by heavy vehicles passing thereover.

The or each loop may be of any suitable shape, for example substantially rectangular, and may, for example, have a length of between 5 and 15 cm and a width (i.e. a depth) of between 1 and 3 cm. In a particular embodiment, a plurality of loops each measure approximately 10 cm x 2 cm.

In a preferred embodiment of the invention, the detector also includes an inductive loop arranged substantially in the plane of the road surface. This conventional loop is used to detect vehicle bodies whilst the or each vertically-orientated loop is used to detect wheels. Preferably, the detector includes means for superposing results obtained from the conventional and vertically-orientated loops and means for displaying the superposed results. Thus, a profile showing both the chassis and the axles or wheels of a vehicle can be viewed.

Brief Description of the Drawings

The present invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic vertical elevation of a vehicle detector according to one embodiment of the invention;

Figure 2 is a schematic transverse section of the detector shown in Figure 1;

Figures 3a and 3b schematically show an alternative embodiment of detector at two different instants for double and single tyres respectively;

Figures 4a and 4b are plots of results obtained from the detector as shown in Figures 3a and 3b respectively;

Figure 5 is a schematic bottom view of a model vehicle;

Figures 6a and 6b are surface and contour plots respectively obtained when the vehicle shown in Figure 5 passes over a detector according to the invention; and

Figure 7 is a plot of superposed results obtained from a combined detector according to another alternative embodiment.

Detailed Description of the Preferred Embodiments

Figures 1 and 2 show a detector comprising a linear array of inductive loops 1, the number of loops being as required to cover the width of carriageway to be monitored. For example about 20 loops can cover a width of 3 m. In this example, each loop measures 10 cm x 2 cm. The array of loops is arranged in a narrow slot 2 extending transversely across a road surface. Each loop 1 comprises a plurality (e.g. 20 to 30) turns of wire. Each loop 1 is both energised and monitored by an adjacent electronic circuit 3, comprising, inter alia, an oscillator and circuitry to convert the oscillation frequency into a proportional signal voltage (not shown in detail). The circuits 3 are very small hybrid or thick-film circuits. The entire array of loops 1 and circuits 3 is housed within a semi-rigid enclosure 4 for protection against the mechanical forces exerted by vehicles passing over the detector.

The signal processing circuitry used to operate inductive loop vehicle detectors is well documented and no special adaptations are required for operating the detector of the present invention. It is not therefore necessary to set out the details of the circuitry herein. An example of such circuitry is described in EP-A-0,649,553, but other known arrangements are equally suitable for use with the present invention.

Figures 3a and 3b schematically show an embodiment of the invention comprising two 10 cm x 2 cm loops 5a, 5b which was built and tested. The two-loop array was mounted in a narrow trench and a large van was driven thereover. Figure 3a shows a front wheel 6 of the van passing over the loop 5a whilst Figure 3b shows doubled rear wheels 7 passing over both loops 5a, 5b. The results are plotted in Figures 4a and 4b, with the solid line showing the ADC (analogue-to-digital converter) reading for the loop 5a and the broken line showing the ADC reading for the loop 5b. Figure 4a shows the recording corresponding to Figure 3a and Figure 4b the recording of

Figure 3b. The outputs are very distinct, giving a clear indication of the presence of the wheel and it is possible to see the difference between the front and rear wheels. The presence of the large conducting area of the underside of the van has not destroyed the data relating to the wheels, as would happen with a conventional loop.

Figure 5 shows the dimensions in mm of a scale model vehicle used to test an experimental embodiment of the invention. The model vehicle had wheels exhibiting the same properties as real vehicle wheels. Figures 6a and 6b show the results obtained as a 3D surface plot and a contour plot respectively.

A practical embodiment of the invention comprises at least one vertically-orientated inductive loop as described above as well as a conventional large flat loop which may be up to 1.5 to 2.5 m long in the direction of travel. Such a combined detector has been constructed. The results from the vertical and flat loops were superposed, the results from the vertical loop firstly being inverted since, as explained above, tyres cause a increase in the loop inductance whilst the vehicle body causes a decrease. The superposed results are shown in Figure 7 as an illustration of what can be achieved. The profile indicates both the chassis and the axles of the vehicle. This could also be displayed as a 3D plot, similar to Figure 6a, if an array of vertically oriented loops is used such as that shown in Figure 1.

When the detector comprises a linear array of miniature loops it is possible to detect the track width and even the size and configuration of the vehicle wheels. The lateral position of the vehicle on the road can be detected and thus a vehicle straddling two lanes of a road is easily identified and is not mistaken for two vehicles. Metal-tracked vehicles can also be distinguished since the tracks will cause a decrease in the loop inductance, whereas tyred vehicles cause an increase in inductance.

The inductive signature of the loop(s) of the invention has a better resolution than that of conventional loops due to the size and orientation of the loop of the invention. This helps to resolve tailgating and nose-to-tail congestion problems encountered by conventional loops. This range of data is not readily available from video processing, even in good weather and lighting conditions.

CLAIMS

1. A vehicle detector and classifier comprising at least one electrically conductive loop arranged in a road surface, characterised in that the or each loop is arranged substantially in a plane perpendicular to the road surface.

2. A detector according to claim 1, characterised in that said plane extends across the road.

3. A detector according to claim 1, characterised in that said plane extends parallel to the axis of the road, i.e. in the direction of travel.

4. A detector according to any preceding claim, characterised in that a plurality of loops are arranged in a line in a single slot cut into the road surface.

5. A detector according to claim 4, characterised in that at least one active electronic component is located in the slot adjacent to each loop.

6. A detector according to claim 5, characterised in that the components are mounted on very small hybrid or thick-film circuits at regular intervals.

7. A detector accoriding to any preceding claim, wherein the loop, or all of the loops, are encapsulated in a semi-rigid enclosure.

8. A detector according to any preceding claim, wherein the or each loop is substantially rectangular.

9. A detector according to any preceding claim, wherein the or each loop comprises a plurality of turns.

10. A detector according to any preceding claim, including an inductive loop arranged substantially in the plane of the road surface.

11. A detector according to claim 10, including means for superposing a result obtained from the loop arranged substantially in the plane of the road surface and a result obtained from the or each loop arranged substantially in a plane perpendicular to the road surface, and means for displaying the superposed results.

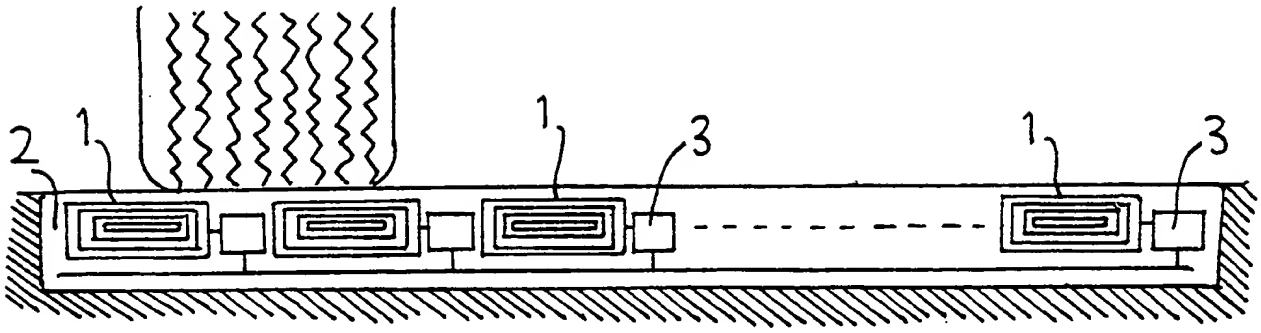


Fig. 1

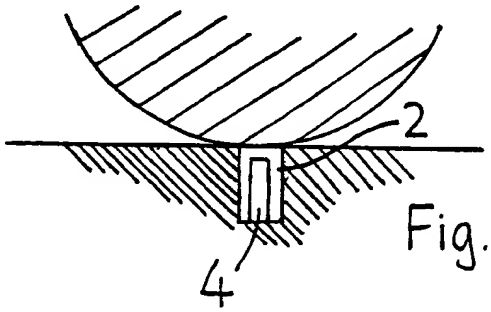


Fig. 2

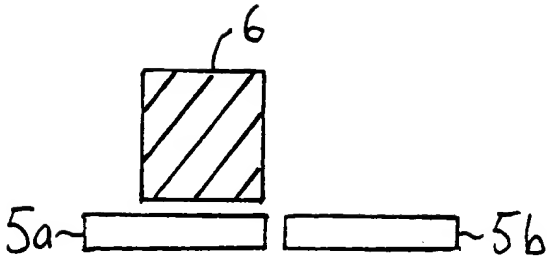


Fig. 3a

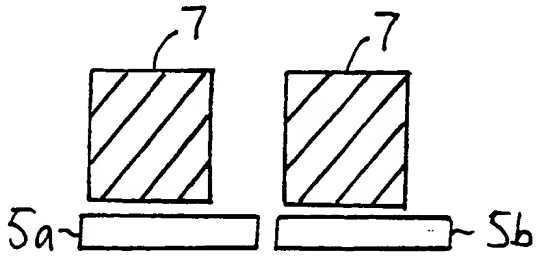
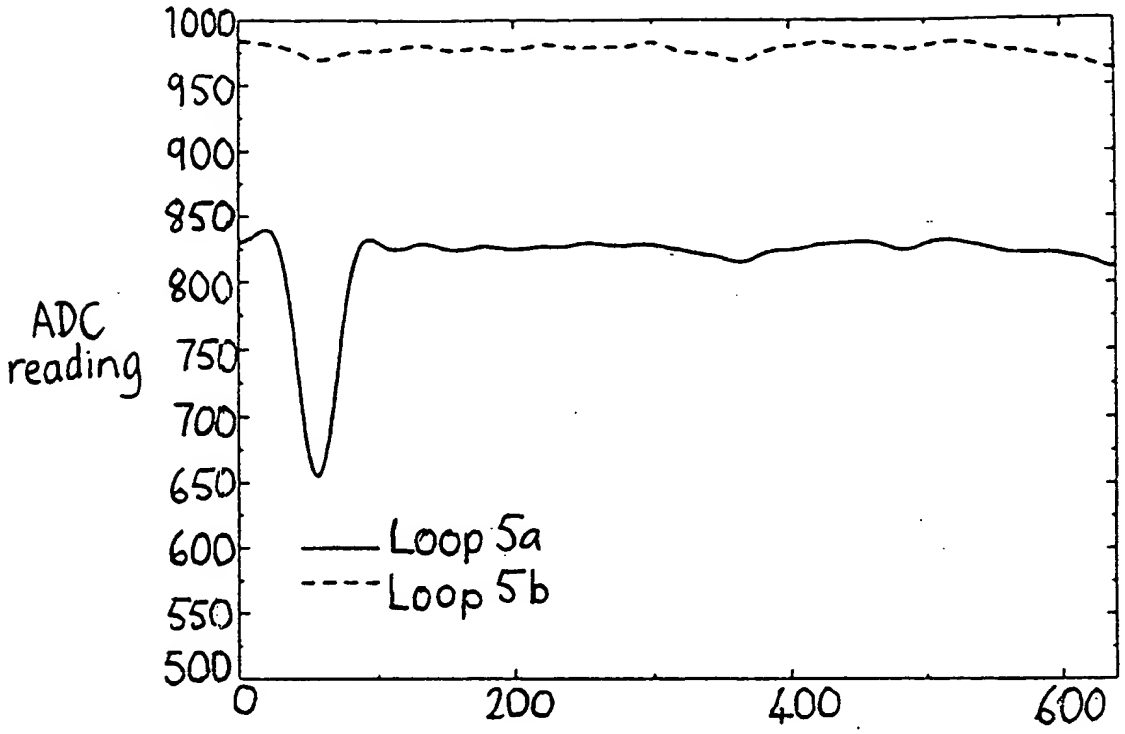


Fig. 3b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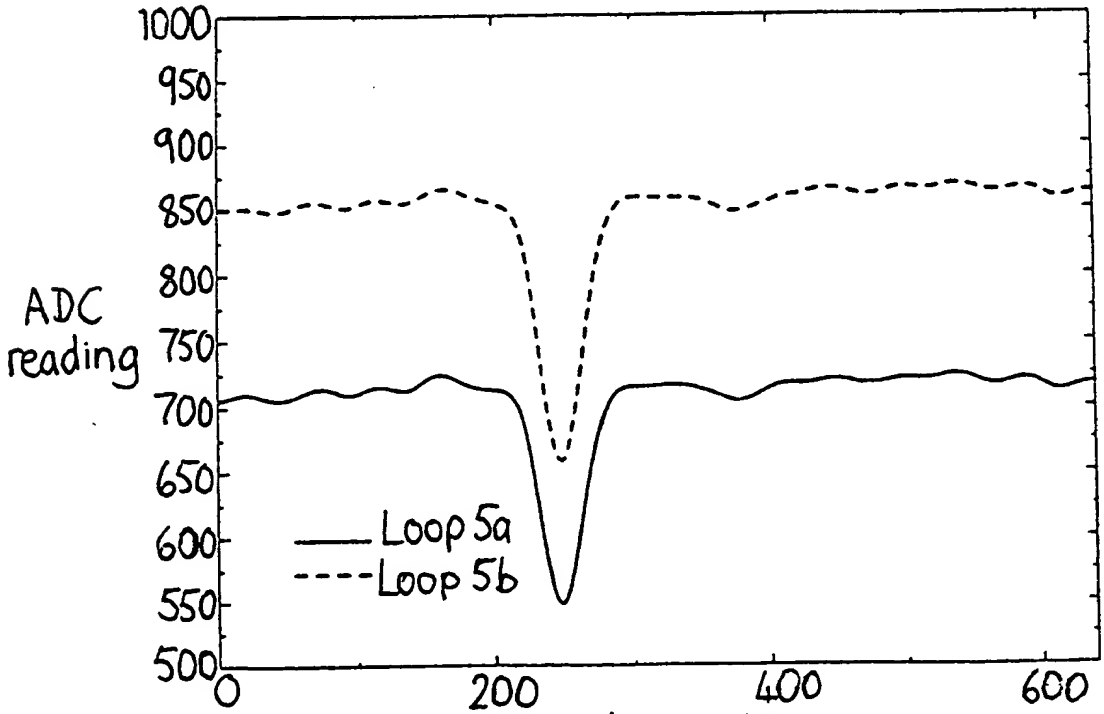
950
900
850
800
750
700
650
600
550
500
ADC reading
Loop 5a
Loop 5b
0
200
400
600
sample number

Fig. 4a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Loop 5a
Loop 5b
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200
400
600
sample number

Fig. 4b

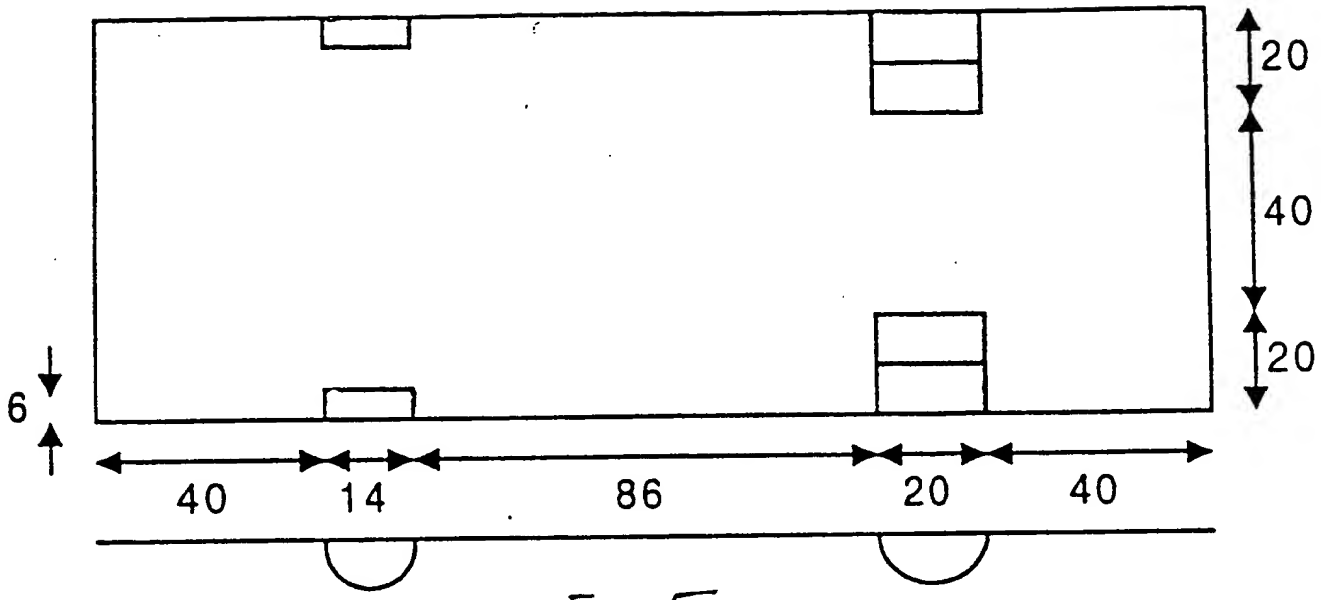
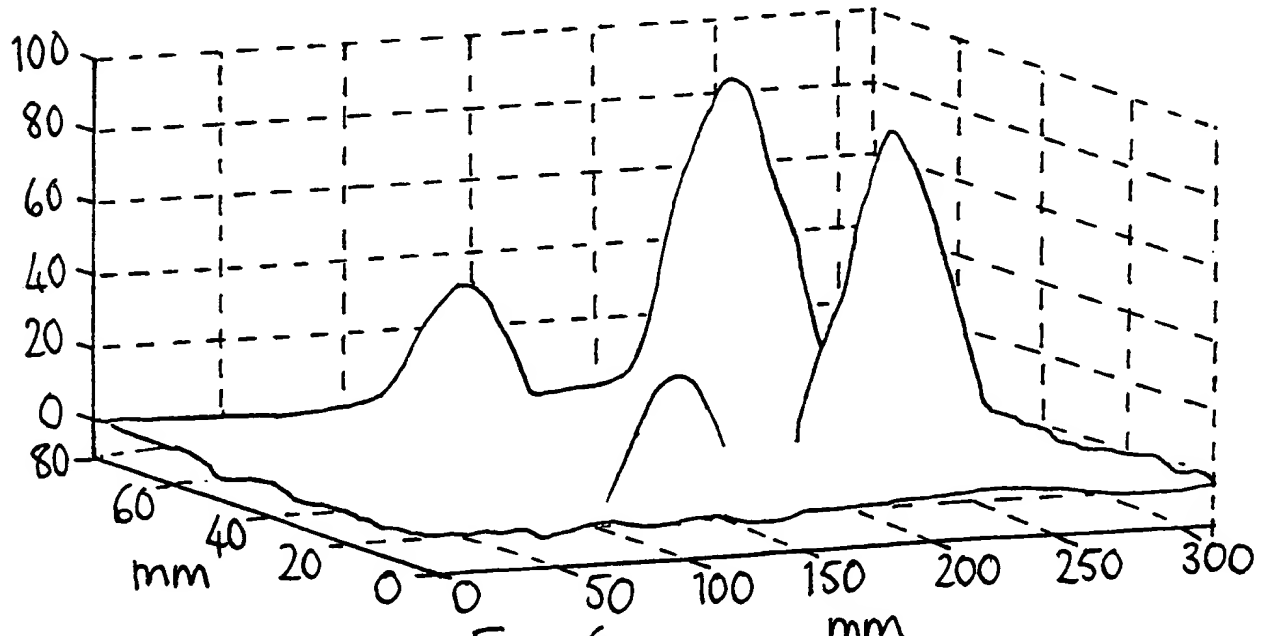

20
40
20
6
40
14
86
20
40
Front
Rear

Fig. 5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mm

Fig. 6a

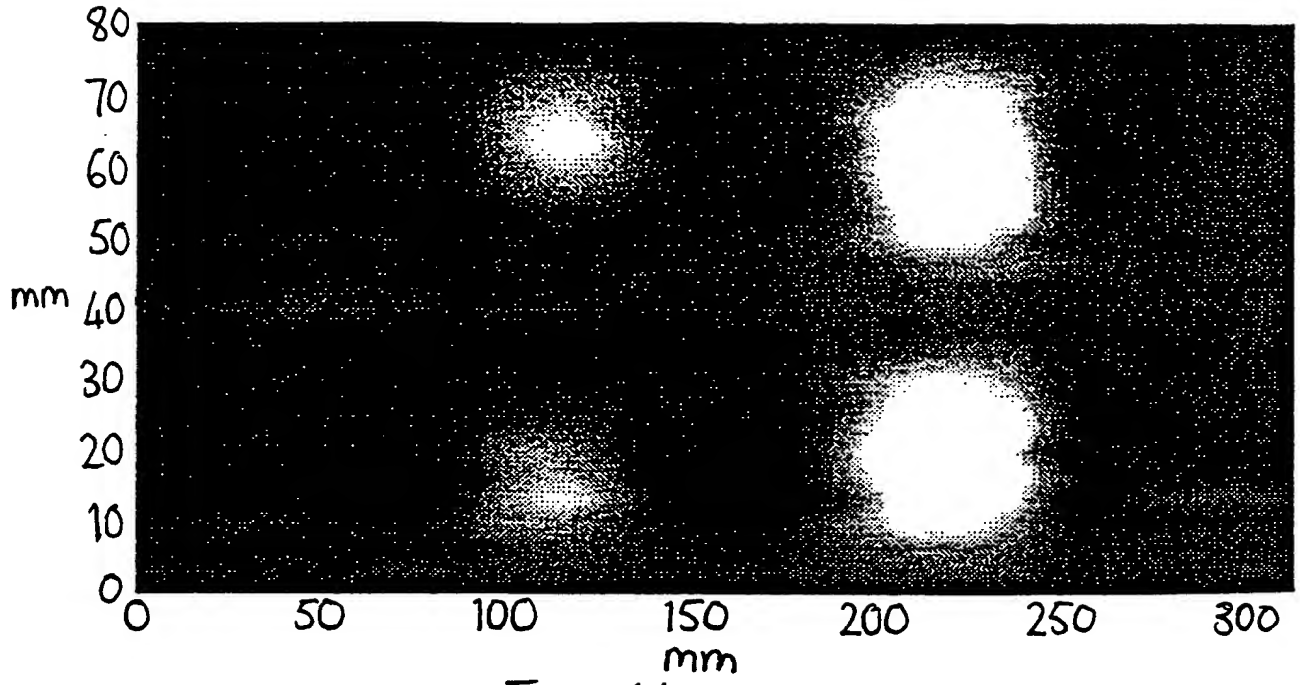
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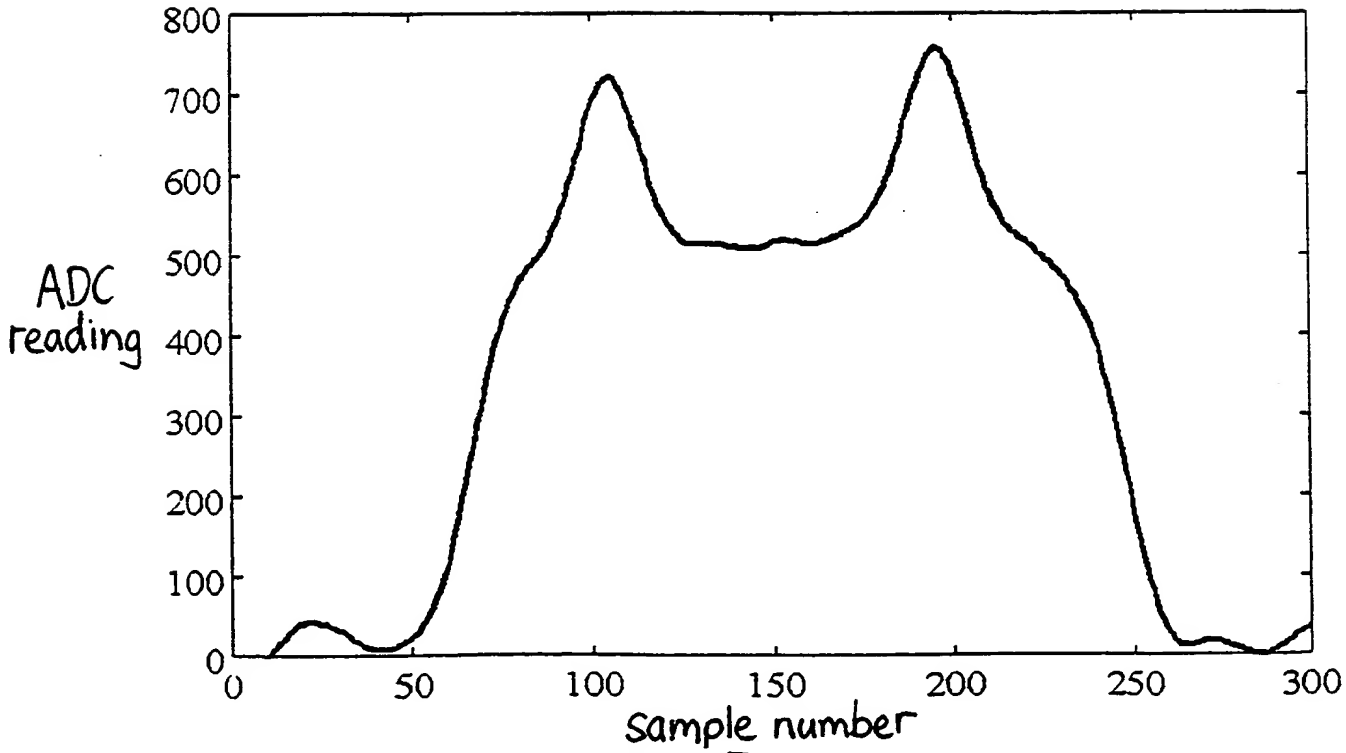
Fig. 6b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ADC reading
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200
250
300
sample number

Fig. 7

INTERNATIONAL SEARCH REPORT

In. .ational Application No
PCT/GB 00/00568

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G08G1/042 G08G1/015

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G08G G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 770 978 A (COUTELLIER JEAN MARC) 2 May 1997 (1997-05-02) column 6, line 2 - line 16; figure 9B	1-11
A	EP 0 841 647 A (DEUTSCHE FORSCH LUFT RAUMFAHRT) 13 May 1998 (1998-05-13) figure 1	1-11
A	DE 195 43 151 A (BRATGE BIRGIT ;GESO GES FUER SENSORIK GEOTECH (DE)) 22 May 1997 (1997-05-22) page 3, line 13 - line 35	1-11

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15 June 2000	26/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Crechet, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

information on patent family members

Int. .tional Application No
PCT/GB 00/00568

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0770978 A	02-05-1997	FR 2740592 A	30-04-1997
EP 0841647 A	13-05-1998	DE 19646632 C	14-05-1998
DE 19543151 A	22-05-1997	NONE	

PATENT COOPERATION TREATY

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

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International filing date (day/month/year) 17 February 2000 (17.02.00)	**Priority date** (day/month/year) 18 February 1999 (18.02.99)
Applicant POVEY, Gordon, Johnston, Robertson et al	

1. The designated Office is hereby notified of its election made:

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Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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APR 15 2002
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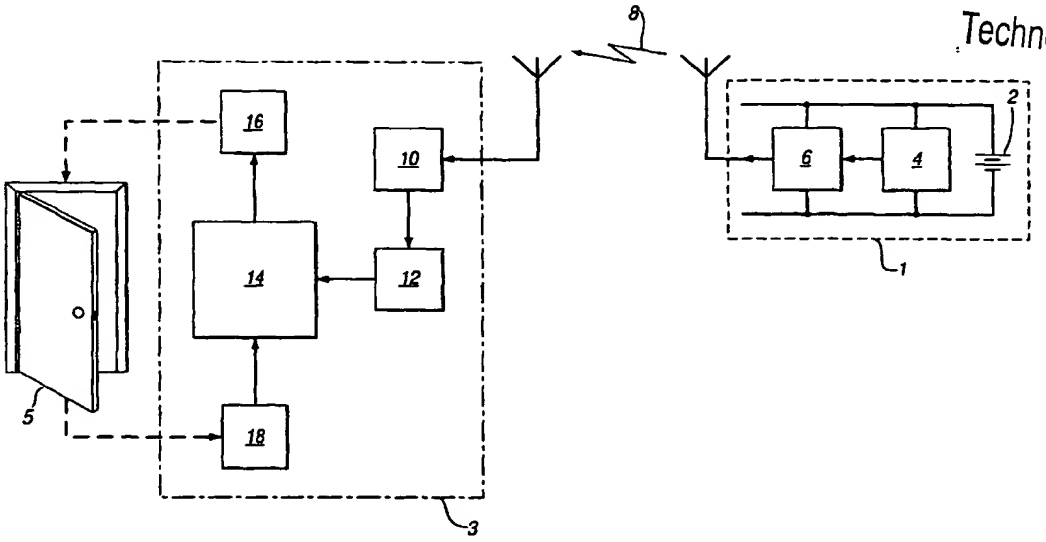
(54) Title: ELECTROMECHANICAL LOCK SYSTEM



(57) Abstract: An electromechanical lock system is presented wherein a personal portable control means including a power supply, a code generator and a radio transmitter is used to control a barrier control means by means of transmission of the appropriate code to open the barrier. In operation, the position of the barrier open or closed is sensed, and upon receipt of the correct code the barrier is unlocked in accordance with the results of a number of logical evaluations which take as their inputs the receipt of a valid code and the sensed state of the barrier. In a preferred embodiment, a time element is also provided to automatically lock the barrier after a pre-set time period has elapsed.

WO 01/61131 A1

Electromechanical Lock System

TECHNICAL FIELD

The present invention relates to an electromechanical lock system that can be fitted to an existing door, gate or similar barrier lock mechanism.

More particularly, the present invention relates to an electromechanical lock system and associated controlling logic that provides a high security barrier system to restrict access through the barrier to authorised personnel only. The system is suitable for domestic or commercial use on fixed premises.

BACKGROUND OF THE INVENTION

Various electromechanical locking systems are well-known in the art. Perhaps the best known and most commonly used systems are the various central-locking systems employed in modern cars. Such a system generally comprises a small low-power radio transmitter mounted upon a key-ring or the like. Upon depression of a push-button incorporated into the key-ring the transmitter transmits a low power coded r.f signal, the code of the signal being unique to the particular car. Provided the radio-transmitter is close enough to the car, the coded signal is received by a matching low-power radio receiver in the central locking system. The received code is then compared to a pre-set code for that particular car, and if found to match the central locking system unlocks the car doors by means of the electromechanical locks commonly found in such systems, the constructions of which are well-known in the art. Precise details of the construction of such electromechanical locks or latches are beyond the scope of this specification. It is common in such systems for all of the car doors to be simultaneously unlocked, although it is possible in some systems to preprogram only a specific number of the doors to become unlocked, such as for instance the driver's door only. Whichever configuration is chosen, car central locking systems are characterised by having only a single central controller which controls

all the doors, whether simultaneously or separately. Furthermore, the operation of such systems is generally quite limited. For instance, a characteristic operation would be simply that in an initial state where the doors are locked, activating the coded transmitter will cause the doors to unlock. A second and subsequent activation would then simply cause the doors to lock once more. The system then simply cycles between the two states with each activation of the coded transmitter. No monitoring of whether the door has been actually opened or if someone has entered the vehicle is undertaken.

With regards to electromechanical locking systems used to secure buildings or other restricted public access areas, various swipe-card/ticket systems are known, a common characteristic being that a key card or ticket must be swiped through or otherwise placed within some form of card reader in order for the barrier to unlock. Such systems have the severe disadvantage that an actual physical operation is required by the user to ensure that the card or ticket is read properly. As will be appreciated by users of various metro systems around the world such as the London Underground, delays can be caused by the need to first find the card/ticket about a user's person and secondly to place the card/ticket in the reader correctly. As such, such systems do not allow for a hands-free operation to unlock the barrier.

There is however, a known "hands-free" system that is employed in some commercial premises that overcomes some of the above-described problems of the common prior art, and which works on the principle of electromagnetic induction. In such a system an authorised user is issued with a "Smart"-card upon which is etched a magnetic circuit. A barrier such as a door which is controlled by the system then has an electromagnetic induction loop placed around it, which generates an electromagnetic field around the door. This field is then carefully monitored.

When an authorised user wishes to enter through the barrier, then they simply approach the barrier, thus passing the Smart-card, which is worn on

their person, through the generated electromagnetic field. The magnetic circuit etched upon the card causes changes in the field as it moves closer to the barrier. These changes may be detected and used to control the door, allowing the door to be pushed open. Once open, the authorised user together with any companions, whether authorised or not, may pass at will through the door until the door is allowed to fully shut and the lock to re-engage. Once the door is open no provision is made to monitor the passage of persons through the door, nor to ensure that each person passing through is an authorised user. Furthermore the method of detection of the presence of an authorised user by passively detecting such a "Smart-card" is prone to error, and it is not uncommon for users to have to spend many minutes waving their cards in front of the door in order for detection to be achieved.

SUMMARY OF THE INVENTION

In contrast to all of the above-described prior art, the electromechanical lock system of the present invention presents a "hands-free" operation which uses the transmission of low-power coded r.f signals to actively signal the barrier to open. Furthermore, each barrier has its own controlling logic resulting in a distributed system with no central control point.

According to the present invention, there is provided an electromechanical lock system providing for remote operation of an electromechanical lock arranged to secure a barrier, comprising:

personal portable control means including portable power supply, a personal code generator and a radio transmitter arranged to transmit said personal code on command from a user; and

barrier control means including:

a radio receiver arranged to receive any transmitted codes;

code recognition means for recognition of any received codes;

barrier sensing means arranged about said barrier for indicating a present open or closed state of said barrier; and

control means arranged to control said electromechanical lock dependent upon the sensed state of said barrier and the recognition of the received codes;

wherein when said received code is recognised by said code recognition means and said barrier is sensed to be closed then said control means control the electromechanical lock to allow the barrier to open.

The control means may further include a timer element arranged to measure a time period after the barrier has become unlocked. Once the time period has elapsed the control means control the electromechanical lock to secure the barrier closed. The time period should be optimally chosen to try and preclude more than one person traversing the barrier at any one time. The time period may therefore be fixed or variable.

The barrier-sensing means may be any of electrically, mechanically, magnetically or optically driven. That is, any known movement or position sensor can be used as the barrier sensing means, provided that reliable detection of the opening and subsequent closing of the barrier, or of the opened or closed state can be provided.

The system of the present invention presents a distributed system with no central controller. That is, when the system of the present invention is to be employed at more than one barrier, each barrier will have its own local logic and control. More particularly, each barrier will have its own radio receiver, code recognition means, barrier sensing means and control means together with its own electromechanical lock. A particular personal portable control means may be common to and compatible with each local set of other components of each barrier, allowing access through each barrier. A particular personal portable control means will be particular to a single user, however, and each authorised user will have his/her own personal portable controller. Such a system has the advantages that no wiring is required to a single central controller. In addition fault tolerance is built in due to the inherent redundancy in such a system.

Furthermore the issue of the personal portable controllers each with a unique code allows the various fixed sets of each barrier to be programmed to give particular users access to some areas and not to others.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will become apparent from the following description of a number of particularly preferred embodiments thereof, and in particular by reference to the accompanying drawings in which:-

Figure 1 shows a first embodiment of the present invention;

Figure 2 shows a schematic block diagram of the important features of a second embodiment of the present invention; and

Figure 3 shows a block diagram of additional features of another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invention will now be described with reference to Figure 1.

The present invention basically consists of two main parts. A personal portable control means 1 is first provided in which a portable power supply such as a battery 2 provides power to a personal code generation circuit 4 which supplies a personal code to a low-power radio transmitter 6. The radio transmitter 6 transmits the personal code over a channel 8 upon command from an authorised user, for instance by pressing a button on the personal portable control means.

The personal portable control means is to be carried about an authorised user's person, and hence is of relatively small and lightweight construction. Key-ring style hand sets are particularly envisaged, and each authorised user would be issued with a personal set.

The second main element of the present invention is the barrier control unit 3. Each barrier employing the system of the present invention would

have its own barrier control unit 3 conveniently located at or near to the barrier. The barrier control unit 3 includes a radio receiver 10 arranged to receive and demodulate any signal transmitted over the channel 8. The received and demodulated signal is then fed to a code recognition circuit 12 which attempts to recognise any code included in the received signal as indicating that the sender of the signal is an authorised user. Code recognition may be by algorithmic or logical means, or alternatively by means of a look-up table contained within the code recognition circuit. Where the received code is recognised as valid a signal is sent to a control means 14 to indicate that the valid code has been received.

The control means 14 also has a second input from a barrier condition sensor 18. The barrier condition sensor is arranged to detect whether or not the barrier is presently open or closed. A signal corresponding to the state of the barrier is then fed to the control means 14.

The control means 14 receives the signals from the barrier condition sensor 18 and the code recognition circuit 12 and applies the two signals to a decision-making circuit to decide whether or not the barrier should be unlocked. The logical rules governing the decision-making process will be described later. The control means 14 controls an electromechanical lock 16 on the basis of the output of the decision-making circuit. The electromechanical lock 16 is arranged to allow the lock to secure the barrier closed. The barrier 5 is shown in the drawing as a door, but it is to be understood that any barrier which can be secured to prevent the passage of a person or persons may be used within the system of the present invention. Suitable other barriers may be such as gates, turnstiles or the like. The electromechanical lock may be constructed integral with the barrier or may be externally added to an existing barrier. The only requirement is that it be actuable upon command from the control means 14, and that it is conveniently situated so as to be able to secure the barrier closed.

The barrier condition sensor 18 may be mechanical, electrical, magnetic, or optical in nature, the only requirement being that it is capable of

detecting that the barrier has been opened and that this can be communicated to the control means 14.

Suitable mechanical means would be a simple conveniently placed switch, whereas suitable electrical means could be for example, a mercury-tilt switch. Magnetic means could be for instance a reed switch such as those commonly used in domestic burglar alarm systems. Optical means could be a conveniently placed optical diode responsive to IR or visible light frequencies.

The control means 14 may further include a timing element in addition to the decision-making circuit. The timing element is arranged to be responsive to the signal from the barrier condition sensor 18 and the signal from the code recognition means 12. The purpose of the timer element is to prevent the barrier from being unlocked for too long, in which case unauthorised access through the barrier might occur. The precise operation of the timing element will become clear from a discussion of the logical rules embodied in the decision-making circuit in the control means 14, described next.

The control means 14 controls the electromechanical lock on the basis of a number of logical rules, which take as their inputs the sensed state of the barrier, the known state of the lock, and the output from the code recognition circuitry. The logical rules are based on the following.

When the lock 16 is locked then a signal from the code recognition means 12 that a valid code has been received will cause the control means to control the lock to unlock.

When the lock 16 is unlocked, the receipt from the code recognition means 12 that a further valid code has been received will cause the control means to control the lock to lock.

When the lock 16 is unlocked, then opening the barrier will be detected by the barrier condition sensor 18 which communicates the open state to the control means which controls the lock to lock. This is appropriate where the lock is a latch-type.

When the lock 16 is unlocked, and the barrier is not opened, then the control means controls the lock to lock after a predetermined amount of time as measured by the timing element.

The above logical rules provide for relatively simple but robust operation of the system according to the first embodiment of the present invention. The timer element in particular helps to ensure that no unauthorised access is made by virtue of automatically re-locking the barrier if no passage is made through the barrier within a predetermined period of time. This prevents the state occurring where the barrier could remain unlocked for a substantial period of time, in which period unauthorised access could occur.

The power supply for the portable control means could be a battery, or alternatively a solar panel, or a combination of the two. Where a combination is used, the battery may be a rechargeable battery arranged to be charged from the solar supply.

The power supply for those fixed elements which are situated at or near to the barrier may be from the domestic mains supply, or alternatively from a battery. Preferably, however, a combination of mains supply with a battery back-up is used. Such a combination allows for emergency battery operation in the event of a power-cut. Where such a combination is used, the battery can further include recharging means to allow the battery to recharge from the mains supply.

A second embodiment including more advanced security features will now be described with reference to Figure 2.

The previously described first embodiment presents the simple case when a sole authorised user approaches the barrier and commands the barrier to unlock using a personal portable control means. Problems can arise however, when more than one authorised user approaches the barrier at once, or where a mix of both authorised and unauthorised personnel desire access through the barrier. Both of these scenarios will be discussed in turn below.

Turning first to the problem of multiple authorised access, the biggest problem facing the system of the present invention is that of contention between users. More precisely, the contention lies between each user's personal portable control means.

Consider the scenario where two authorised users approach the same barrier and each press their handsets at the same time. Two signals will then be transmitted onto the channel 8 at the same time, resulting in interference between the two signals and decreasing the likelihood that a clear signal is received by the receiver 10.

There are several solutions around this problem, any of which may be employed within the present invention.

The simplest is to simply set the transmission frequency of each of the transmitters 6 in each of the portable control means 1 to be different. In this way a FDM radio link can be established which will solve the problem of interference between signals. The disadvantage of this is that the receiver must be made relatively wide band with respect to the received signal, thus decreasing the signal to noise ratio of the received signal which is manifested by a reduced range of the handset. Furthermore, such FDM techniques do not solve the problem of which of the two users actually caused the door to unlock and hence is technically the person allowed to pass through the barrier.

A better solution is to employ time division techniques to resolve contention between users. Various such techniques can be employed, and will be demonstrated with respect to Figure 2. Only those parts essential to understanding have been shown in Figure 2, although it is to be understood that those essential parts of the present invention previously described but not shown are to be implicitly included.

In Figure 2, each of the personal portable control means 1 is further provided with radio receiver 20, which is arranged to receive any signals placed on the channel 8, whether transmitted by the barrier control unit 3, or another

portable control means 1. The barrier control unit 3 is provided with a radio transmitter 22, arranged to transmit onto the channel 8, although such a transmission could be at a different frequency. Such arrangements allow for a variety of methods of defeating the multiple user contention problem.

A first such solution is to simply provide an acknowledgement signal from the control unit 3 onto the channel via the transmitter 22. Such an acknowledgement signal could be simply the first received code retransmitted. When this is the case, the retransmitted code can be received by all of the handsets and compared to their own codes. The particular handset which then transmitted the accepted code could then indicate acceptance to the user, for instance by suitable indication means such as a vibrator, a flashing light, or an audible alarm. In order to avoid contention with the transmitted codes from the handsets, the transmitted acknowledgement can be at a different frequency.

Further solutions to avoiding contention can be found by applying various techniques found in the field of contention LANs.

In particular "listen-before-send" and "listen-while-send" techniques can be employed.

With the former technique, after the user has commanded the handset to transmit its code, instead of sending the signal immediately, the radio receiver samples the channel to ensure that no other handsets are transmitting. If no other signals are detected then the transmitter 6 is signalled to transmit the code. If, however, the channel is already busy, then the transmitter 6 is prevented or delayed from transmitting the code. Two options are available for delaying transmission of the signal. The first is that the code transmission may be delayed from transmission for the duration of the transmit time of a similar code. In this case, almost immediately after the already transmitting code has finished, the present code can be transmitted. Thus the barrier control unit 3 would receive two codes from different users in quick succession.

A second option is that the handset prevents the code transmission

for the duration of time that it would take for a person to transit the barrier and for the barrier to relock. This then provides an automatic delay which helps prevent more than one person transiting the barrier device at once. Such a system has drawbacks in that there is the statistical potential that a user could always find himself blocked by other users who happen to start their transmissions just before him. In such a case it may take minutes to transit the barrier and hence frustration could result.

With "listen-while-send", after the user has commanded the transmitter to transmit, the receiver monitors the channel to ensure that no other handsets also start transmitting during the duration of its own transmission. If, however, a second transmission and hence contention occurs then the first transmitter is stopped from transmitting, and a delay applied before transmission is attempted again. The delay must have a degree of random back-off to prevent contention between the two handsets from repeatedly occurring.

By combining the "listen-before-send" or "listen-while-send" techniques with automatic acknowledgements as described earlier, then contention between two or more users can be resolved.

The problem of how to prevent more than one person transiting the barrier at once in an unauthorised manner will now be described by way of a third embodiment of the present invention with reference to Figure 3. Figure 3 shows the important elements of the additional features of the third embodiment. The previously described features of any of the first and second embodiments are to be implicitly regarded as being included with the third embodiment.

In Figure 3 there are further provided time integral thresholding means 32, barrier transit detection means 34, and alarm means 36. The time integral thresholding means 32 receive an input from the code recognition means 12 and from the barrier transit detection means 34. The barrier transit detection means 34 are arranged about the barrier and detect the passage of a person or persons through the barrier. The transit detection means could be, for example,

a pressure plate on the floor upon which people transiting the barrier step, or alternatively some form of optical sensor which detects the passage of people through the barrier. It is possible to include the integral thresholding means 32 within the control means 14 in which case the input from the barrier transit detection means 34 would be fed to the control means 14.

The alarm means 36 are controlled by the time integral thresholding means 32 and are used to signal when an unauthorised access has occurred. The alarm means could be a sounder as shown, or alternatively a flashing light or other such attention-grabbing means. Alternatively, a camera or the like could be rigged to take pictures of the people transiting the barrier when an unauthorised access is detected.

The principle of operation is as follows. Assume that a valid code has been received and recognised by the code recognition means 12. The recognition means then output a signal to the control means 14 to unlock the door and also to the time integral thresholding means 32. Within the time integral thresholding means a pre-set threshold value is selected which is an integral value representing the maximum allowable time for a single person to transit the barrier. The barrier transit detection means begins to provide a signal to the time integral thresholding means 32 once a transit has started to be detected, and for the duration of the barrier transit. This signal is integrated with respect to time and continuously compared to the pre-set threshold value. If the resultant integrated signal exceeds the pre-set threshold then this is an indication that the barrier transit is taking longer than specified, which could be indicative of unauthorised persons attempting to enter immediately behind the authorised person. In this case, when the threshold is exceeded, the alarm 36 is activated.

Such a time integral system has many benefits. For example, consider the case where two valid codes are received from two different users in quick succession. In this case, a different pre-set threshold value may be selected in the time integral thresholding means, the second threshold value corresponding

to the maximum time allowed for two users to transit the barrier. Hence, the two users may transit the barrier together without the need for the barrier to shut, re-lock, and then re-open for the second user. However, if only one code is received then the first lower threshold level is selected corresponding to one transit, and hence two people transiting should be detected. By integrating the signal within the time thresholds selected, then signal flicker caused by, for example, one person leaving the barrier just before the second person enters it can be avoided. The time integral thresholding means can contain a look-up table containing the threshold values required for many users at once. In this way, multiple authorised users can be accommodated at once.

The present invention therefore presents an electromechanical locking system which improves upon all of the prior art. The distributed nature of the system and active signalling provide for robust operation and improved redundancy. For example, with a centrally controlled system then an error in the central control may result in all barriers being inaccessible at once. The distributed nature of the present invention overcomes this problem. Furthermore, the present invention prevents a variety of techniques for overcoming the contention problems met when multiple users attempt to simultaneously access the barrier, and also presents a means of detecting unauthorised access through a barrier. By combining the various described elements of the present invention as described, an adaptable and robust electromechanical lock system suitable for domestic or commercial use can be obtained.

While the above description has been given in relation to the passage of a person through a barrier it will be appreciated that with some modification the above system could be applied to any animate or inanimate object passing through a barrier. The term person and personnel should be interpreted accordingly in the light of this.

CLAIMS:

1. An electromechanical lock system providing for remote operation of an electromechanical lock arranged to secure a barrier, comprising:

personal portable control means including a portable power supply, a personal code generator and a radio transmitter arranged to transmit said generated personal code on command; and

barrier control means including:

a radio receiver arranged to receive any transmitted codes;

code recognition means for recognition of any received codes;

barrier sensing means arranged about said barrier for indicating a current open or closed state of said barrier; and

control means arranged to control said electromechanical lock dependent upon the sensed state of said barrier and the recognition of the received codes;

wherein when said received code is recognised by said code recognition means and said barrier is sensed to be closed then said control means control the electromechanical lock to allow the barrier to open.

2. An electromechanical lock system according to claim 1 wherein said control means further include a timer element arranged to measure a time period after the barrier has been unlocked, wherein after said time period has elapsed the control means control the electromechanical lock to secure the barrier closed.

3. An electromechanical lock system according to claim 2, wherein said time period may be either fixed or variable.

4. An electromechanical lock system according to any of the preceding claims wherein the barrier-sensing means are any one of or a combination of

electrical, mechanical, magnetic, or optical sensing means.

5. An electromechanical lock system according to any of the preceding claims wherein in case more than one barrier is to be secured by said system then each barrier has a respective one of each of said radio receiver, said code recognition means, said barrier sensing means and said control means, whereas said personal portable control means may be common to each of said barriers whereby each of said barriers may be responsive to at least one personal control means.

6. An electromechanical lock system according to any of the preceding claims, wherein said personal portable control means further includes a radio transmitter.

7. An electromechanical lock system according to any of the preceding claims, wherein said barrier control means further includes a radio transmitter arranged to transmit acknowledgements of any received codes.

8. An electromechanical lock system according to any of the preceding claims, and further including

barrier transit detection means arranged to detect the transit of a person or persons through said barrier;

time-integral thresholding means arranged to receive a detection signal from said barrier transit detection means and to receive a signal from said code recognition means; and

alarm means controlled by said time-integral thresholding means;

wherein said time-integral thresholding means integrates the detection signal with respect to time and compares the integrated detection signal with a selected pre-set threshold value and controls said alarm means on the basis

of said comparison.

9. An electromechanical lock system according to claim 8, wherein said pre-set threshold value is selected by said time-integral thresholding means from a look-up table.

10. An electromechanical lock system according to any of the preceding claims wherein said control means applies one or more logical rules to control said electromechanical lock.

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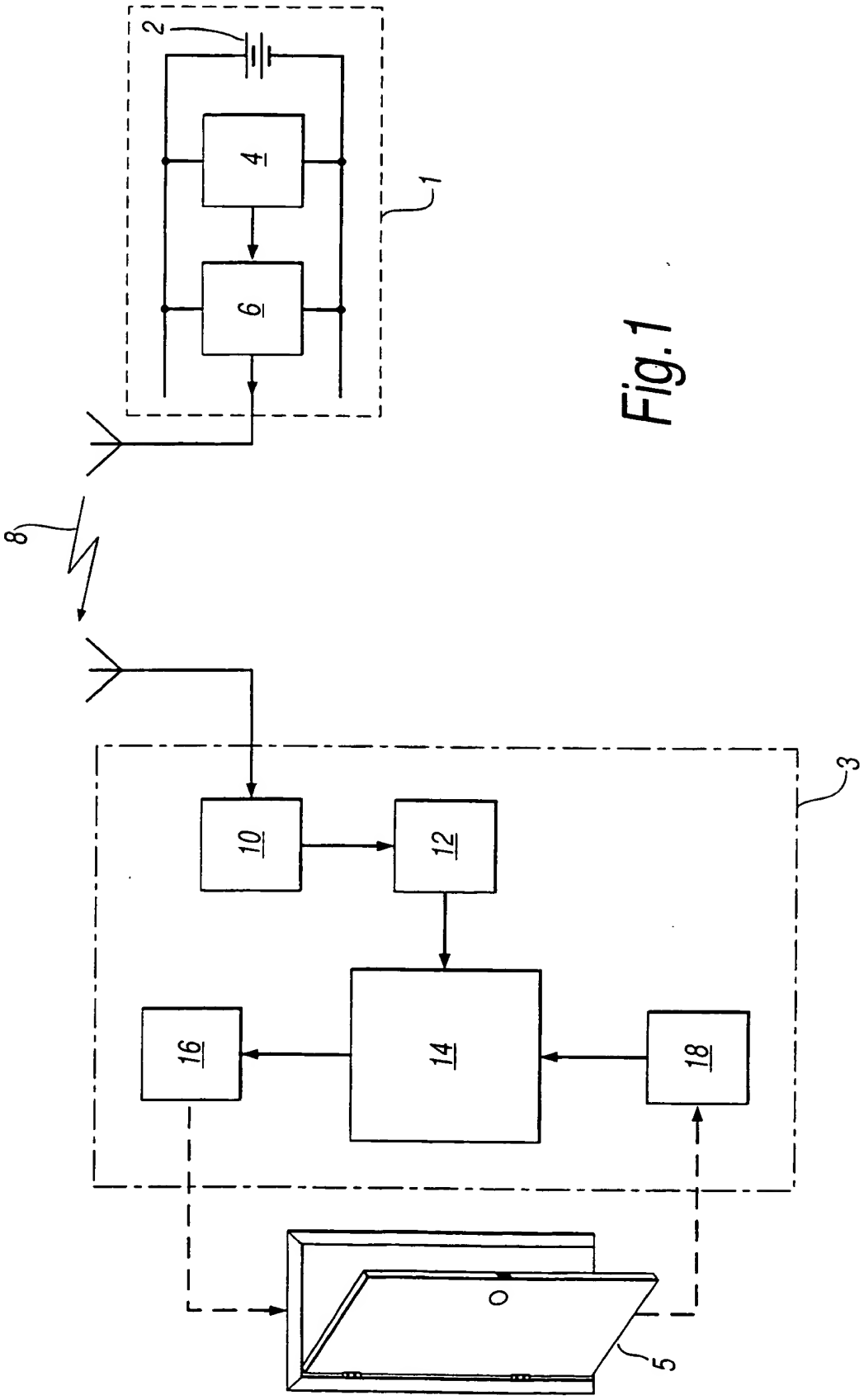

Fig.1

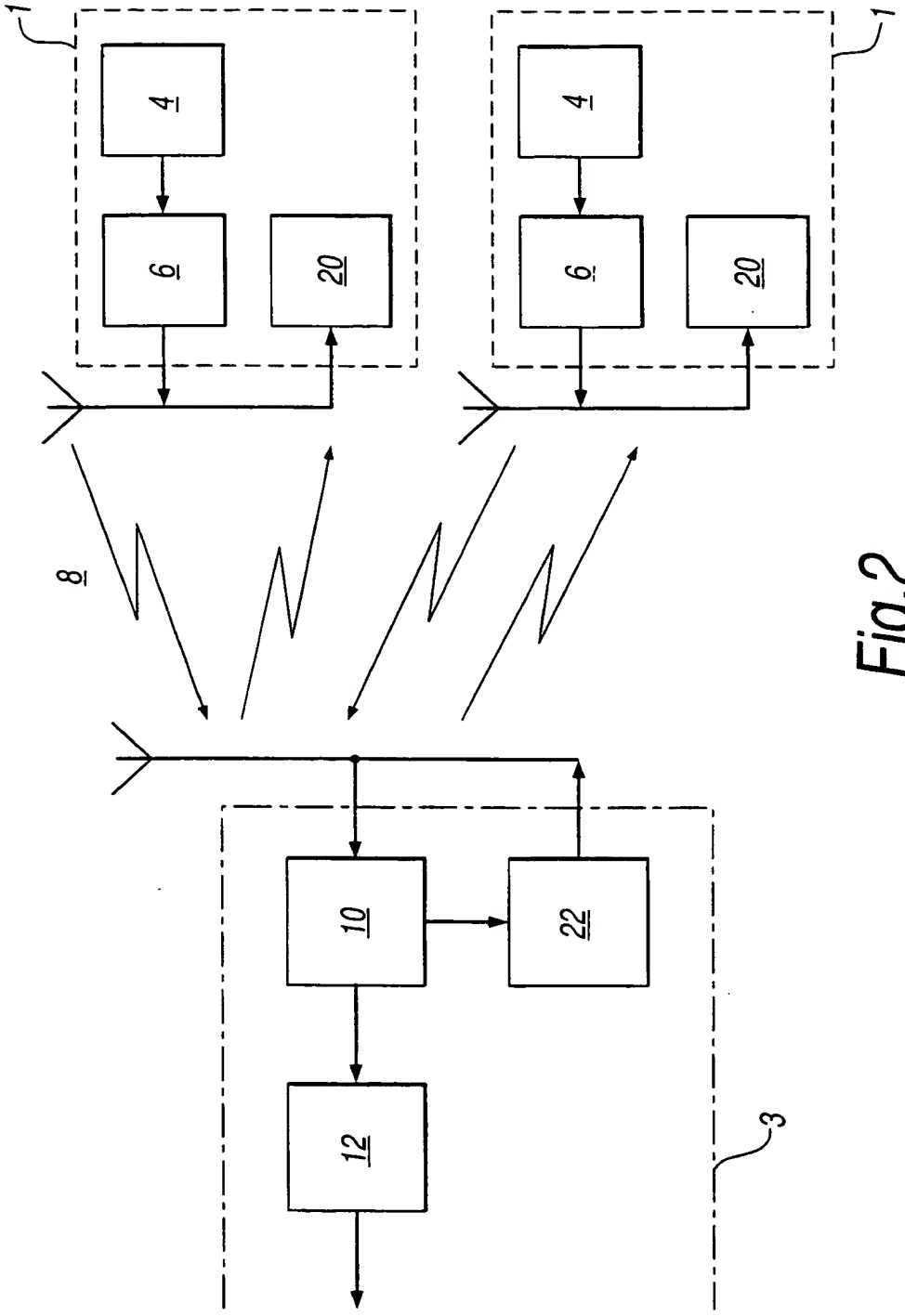

Fig.2

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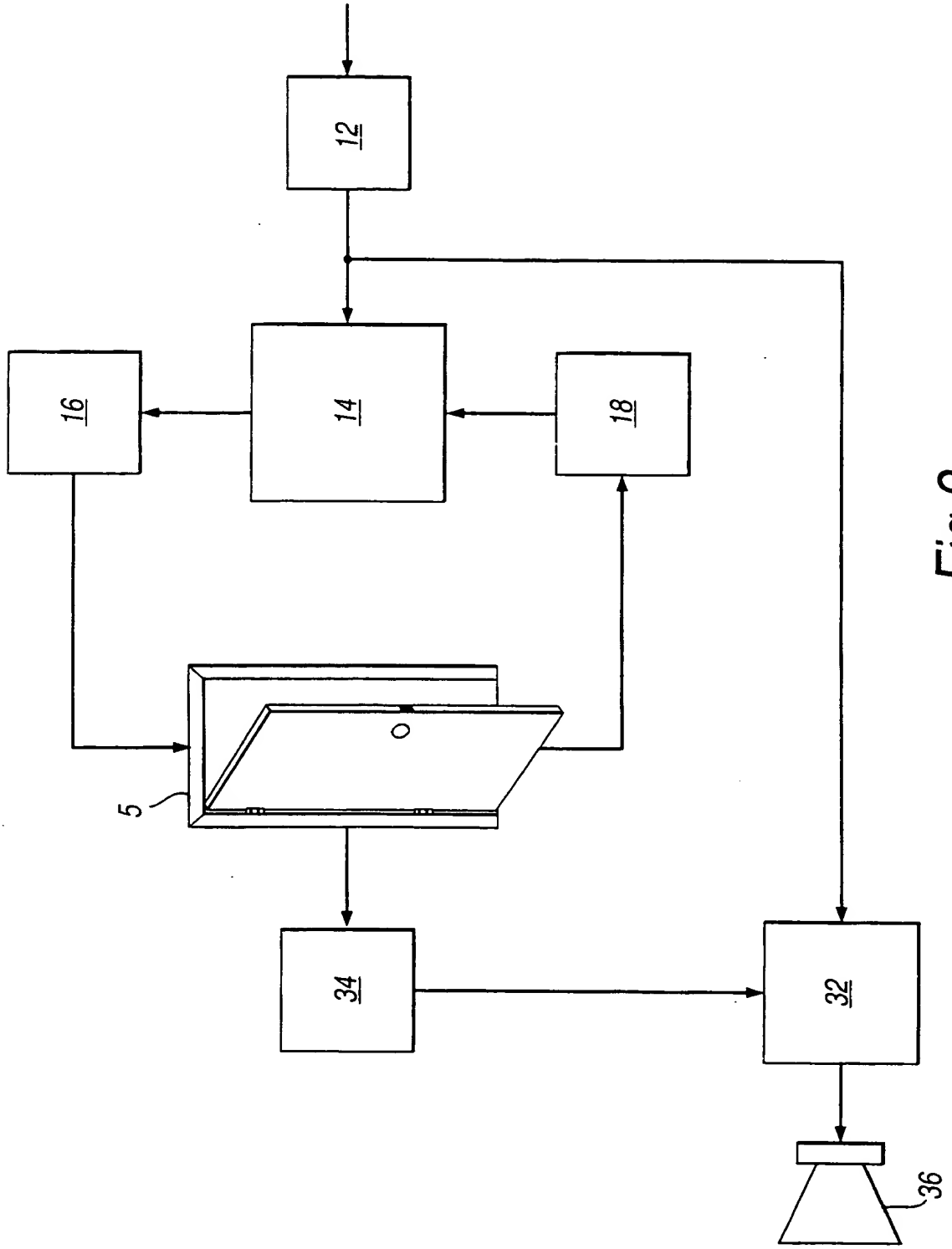

Fig.3

INTERNATIONAL SEARCH REPORT

Int. Jonal Application No
PCT/GB 00/00598

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E05B49/00 G07C9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G07C G07B E05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 0 502 234 A (SIEMENS AG) 9 September 1992 (1992-09-09) abstract; figure column 1, line 1 - line 5 column 2, line 11 -column 3, line 54	1,2,4,6, 10
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X	US 4 847 542 A (CLARK JOHN ET AL) 11 July 1989 (1989-07-11) abstract; figure 1 column 3, line 39 -column 6, line 49 column 7, line 60 -column 8, line 9	1,6,10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 October 2000	25/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Buron, E

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Inte .onal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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